Semiannual Progress Report No. 4

OPTICAL AND RADAR INVESTIGATIONS OF SIMULATED AND NATURAL METEORS

Research Grant NsG 536
from the
National Aeronautics and Space Administration

15 February 1965 to 15 August 1965

Smithsonian Institution
Astrophysical Observatory
Cambridge, Massachusetts 02138

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I. Introduction

The National Aeronautics and Space Administration research grant no. NsG 536 to Smithsonian Institution is for optical and radar investigations of simulated and natural meteors. This is a cooperative enterprise between the Langley Research Center of NASA and the Smithsonian Astrophysical Observatory (SAO); members of both scientific staffs participated in the formulation of the scientific program.

SAO has established and operates observing systems of two types: (1) a Super-Schmidt camera network for measurement of the light produced by the simulated meteor and (2) a radar network for measurement of the associated ionization. The simultaneous observation of an artificial body of known characteristics by both optical and radar techniques will provide valuable information for the particular event observed and for the correlation of any optical meteor data with any radar data.

The unique possibility of obtaining simultaneous optical and radar data with the identical systems for both simulated and natural meteors is the scientific potential of the program.

Dr. Richard E. McCrosky is the principal investigator of the Optical Program, and Dr. Gerald S. Hawkins is the principal investigator of the Radar Program.

II. General Remarks

During the period of this report the Smithsonian cameras continued to support the general NASA launch operations. In particular, observations were made on the meteor simulation that was launched by the Nike-Cajun rocket on 4 May. The re-entry was detected photographically at spaced stations and was also recorded on the multistation radar system. This constitutes the first optical-radar tracking of an artificial meteor, preliminary results of which are described in this report. An account of the program was given by A. Wineman and Dr. R. B. Southworth at the Smithsonian Symposium on Meteor Orbits and Dust held in Cambridge, Massachusetts, August 9-13, 1965.

Natural meteors were observed during this period and provided a useful operational check on the optical radar system. The optical data, however, were obtained from only one station; triangulation was therefore not possible.

Optical data were obtained on two Trailblazers in the M.I.T. program.

III. Super-Schmidt Photographic Data of Simulated Meteors

Table 1 gives the observed velocities and magnitudes of the re-entry particles of the three experiments launched at Wallops Island in 1964 and 1965. The data are preliminary and will be refined in a later report.

TABLE 1. Observed Velocity and Magnitude of Artificial Meteors from Super-Schmidt Photographs

Date of launch (U.T.)	Vehicle	Expt. no.	Meteoroid composition	Velocity at beginning (k/sec)	M_{pg} at maximum
12 March 1964	Nike-Cajun	I	Fe pellet	9.0	+1.0
			Ni pellet	> 8.5	+3.5
7 November 1964	Nike-Cajun	II	Fe pellet	9.6	-0.5
			Fe dustball	11.0	-2.2
4 May 1965	Nike-Cajun	III	Fe dustball	11.0	-1.2
			Ni pellet	10.2	+2.2

IV. Radar Data

Preliminary reduction of the radar data obtained from the Nike-Cajun firing of 4 May 1965 shows that we obtained:

(1) An echo from the first shaped charge (for the nickel pellet), at Oyster Creek, Oriental, and Swansboro;

(2) Delayed echoes (after winds have twisted the trail) from the first (nickel pellet) trail, at all stations except the Range Recoverer;

(3) Delayed echoes from the second (iron dustball) trail, at all stations;

(4) Specular echoes from the trails of both of the larger nickel fragments, at both Oriental and Swansboro; and

(5) A probable specular echo from the trail of the iron dustball, at Oyster Creek.

The radar magnitude at maximum of all the trails of the nickel fragments taken together was +7. The observed radar magnitude at maximum of the trails from the iron fragments was +6; this trail would doubtless have been much brighter if there had not been interference between the radar returns of the various fragments.

Preliminary values of the ionizing probability β are:

Material	Ni	Fe
Velocity	11. km/sec	10.
β	2.1×10^{-5}	$> 1.5 \times 10^{-5}$

V. Equipment and Stations

Several improvements were made in the optical and radar systems. The second Super-Schmidt camera was modified in January, and the Sandbridge camera house was completed in April of this year. The new prism is nearing completion, with delivery scheduled for August. After conducting initial tests, we expect that the prism system will be operational by early fall.

Further modifications were made to adapt the radar transmitter to shipboard operation. Excessive noise in the receivers was experienced at all radar sites and has been partially corrected. Additional grounding and shielding will be introduced to attain further improvement. During this period the entire radar system was completed according to the original design and proposals. Minor modifications and refinements will be made as and when required.

The NASA Wallops facility has agreed to provide additional and improved working space for headquarters for the Smithsonian stations engaged in the simulated and natural meteor project.

Multistation optical and radar observation of natural meteors will commence in the late summer.